SAFEGUARD CORAL REEFS

Building a Rain Garden to Filter Stormwater

Problem

Stormwater runoff picks up harmful pollutants like nitrogen, phosphorus, sediment, heavy metals and petroleum residue as it makes its way across urban landscapes on its journey to the sea. In Hawai'i, stormwater runoff regularly causes the Department of Health to issue "Brown Water Advisories" – warnings to the public that the water is potentially contaminated and poses a health threat to swimmers. Stormwater pollution also harms coral reefs and other marine life.

Photo by West Maui Ridge to Reef Initiative

Solution

Building a rain garden can be an effective, low-cost tool to reduce stormwater pollution reaching our streams and the ocean. A rain garden is a landscaped depression in the ground designed to collect polluted stormwater runoff from rooftops and other impervious (paved) surfaces. When it rains, rain gardens capture a set volume of stormwater. After the rain, this water filters through vegetation and sinks safely into the ground instead of running off into a storm drain or water body. Not only is a rain garden a beautiful landscape feature, but it also protects streams and the ocean from polluted stormwater runoff.

How-to Guide

The instructions below outline how to build a new rain garden, but you can also use these guidelines to improve water filtration within your current landscape by retrofitting existing flower beds or gardens.

Step 1: Choose your location

Successful rain gardens should include the following attributes:

Near the runoff source: It is logical to place a rain garden close to the source of stormwater runoff that you want to treat, such as, near a roof gutter downspout, alongside a parking lot or next to a roadway or other impervious surface. However, stormwater can also be piped over some distance if there is not a suitable site for a rain garden near the runoff source.

Well drained: Rain gardens should not be located in areas where water tends to pool when it rains, as this indicates a low level of soil permeability. Rain gardens need an infiltration rate of at least a half-inch per hour. Please refer to the simple infiltration test below.

Not too steep: Because it is important for the bottom of a rain garden to be flat, constructing one on a steeper slope will require more digging. Experts recommend the maximum slope (angle) be no greater than 12 percent.

Away from structures: Because rain gardens are designed to collect water, it's a good idea to place them at least 4 feet away from buildings, sidewalks or other paved areas so as not to impact these structures. For the same reason, they should be located at least 10 feet away from stone walls, retaining walls or basements, which can flood in a storm. It is important to stay clear (at least 10 feet) of drain fields, septic tanks or cesspools where saturated soils may impede the proper functioning of these structures.

A place for overflow to go: During periods of especially heavy rainfall, stormwater may overflow the rain garden. If this happens, the stormwater needs to be directed to a suitable place – ideally a yard, existing storm drain or another rain garden where additional filtration can occur.

Step 2: Determine the correct size for your rain garden

The optimal size for a rain garden depends on three factors: the surface area that will contribute stormwater to your garden; soil drainage characteristics; and the rainfall in your area. Follow the steps below to create a successful rain garden:

A. Find the contributing area

To determine how much stormwater will be directed into your rain garden, calculate the approximate contributing area (square footage) of the impervious surface being treated by the rain garden.

Note: If you want to calculate the contributing area from an area that concentrates runoff such as a rooftop with downspouts, first calculate the contributing area of the roof, e.g. 25 feet x 40 feet = 1000 square feet. Then divide this area by the number of gutter downspouts (e.g. 4) to determine the contributing area per downspout. In this example 1000 / 4 = 250 square feet.

Illustrative example: Suppose we want to design a rain garden to treat the runoff from a parking lot that is 20 feet X 30 feet. The parking lot has a contributing area of 600 square feet.

B. Determine the soil drainage characteristics

Soils found in Hawai'i vary substantially from impervious clays that do not drain well enough for a rain garden to porous sands and lava cinders that are perfect for a rain garden. The soil drainage characteristics of a site will determine the overall size a rain garden needs to be to filter stormwater effectively. You can determine the infiltration rate using the following simple test:

1. Dig a hole at the approximate center of the rain garden site to a depth of about 15 inches.
2. Fill the hole to just below the top with water and allow it to drain away. Note, this may take several hours. Repeat this step two more times to simulate the conditions on your site when the soil is saturated as it would be after a long period of rainfall.
3. On the third fill-up, measure the depth of the water and start a timer.
4. After the water level has dropped by at least 1 inch, you can calculate the infiltration rate by dividing how much the water dropped (in inches) by the time it took to drop (in hours).

Illustrative example: If the water level dropped by 5 inches over 4 hours, divide 5 by 4, which equals 1.25, giving you an infiltration rate of 1.25 inches per hour.

C. Calculate the right size for your rain garden

Use the infiltration rate at your site to identify the right sizing factor for your rain garden using the table below. This table was modified from Hui o Ko'olaupoko's Hawai'i Residential Rain Garden Manual and created from historical rainfall data from Hawai'i.

INFILTRATION RATE IN/HR	SIZING FACTOR
0.5	20%
.75	13%
1	10%
1.25	8%
1.5	7.5%
2	7%
4	4.5%
6	4.5%
8	4%
10	3.5%
12	3%

Illustrative example: We calculated that our parking lot has a surface area of 600 square feet, and the results of our soil infiltration test yielded an infiltration rate of 1.25 inches per hour.

Contributing area = 600 square feet
Infiltration rate = 1.25 in/hr
Sizing factor = 8% (based on table)
600 x .08 = 48 square feet

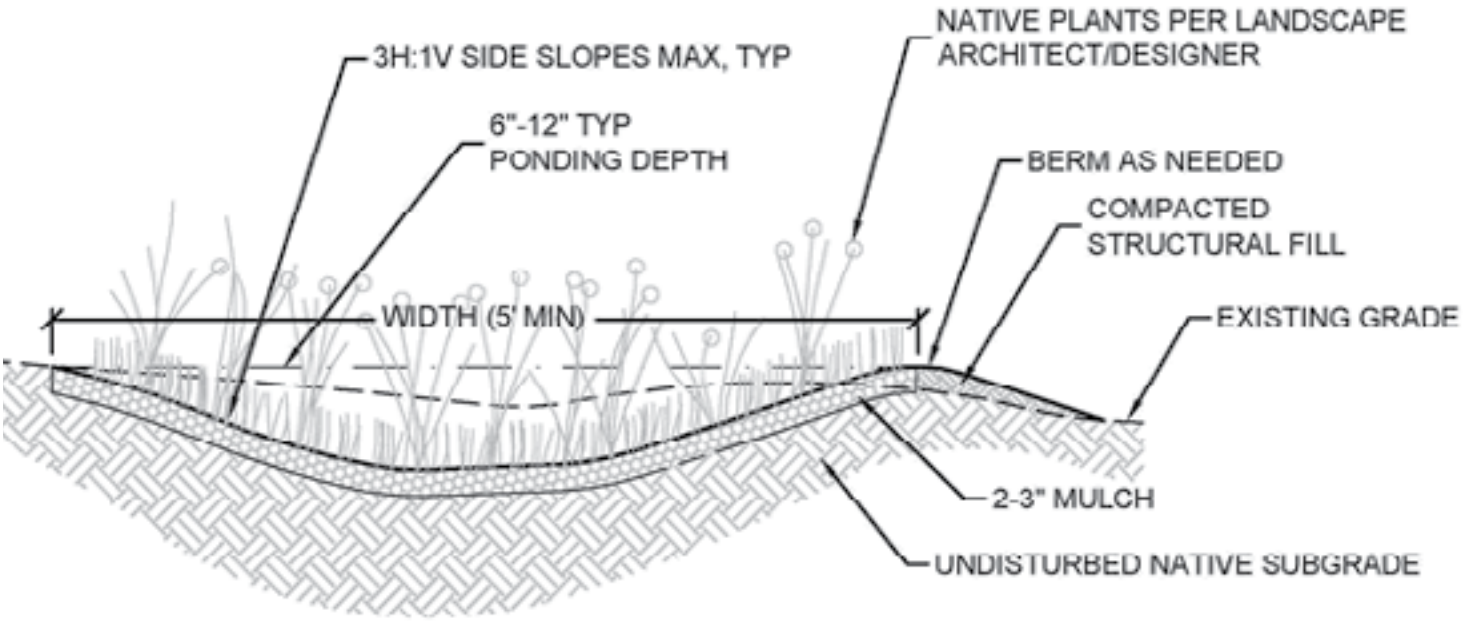
Therefore the rain garden in this example needs to be approximately 48-square feet in size. This can be accomplished with a 6 x 8-foot rectangle, kidney or oval shape with the same approximate area or any variety of shape desired that fits the overall property's landscape aesthetic. In general, a rain garden should be no smaller than 20 square feet in size.

Step 3: Start digging

Digging the rain garden can be easily done by hand, ideally with some willing volunteers. Alternatively, excavating equipment can be used. It is important that the soil at the bottom of the rain garden does not become compacted, so keep heavy equipment out of the rain garden and limit the amount of foot traffic in it to keep the soil light and fluffy. The bottom of the rain garden should be excavated to approximately 12 inches deep to allow for a 2 to 3 inch layer of compost to be mixed with the soil. Optionally, you can choose to dig a deeper excavation site, which allows more room for soil amendments such as sand gravel and extra compost to improve infiltration.

Excavated soil removed to form the rain garden depression can be used to construct a slightly raised berm that goes around the perimeter of the rain garden. If the rain garden is on a slope, this soil can be used to construct a berm on the downhill side of the rain garden. The rain garden's sides ideally should have a gradual slope to prevent erosion and accommodate plants of differing watering needs; plants that thrive in drier conditions should be on the top, and water-tolerant plants should be on the bottom. As long as the bottom of the rain garden is level, and an overflow structure is provided, there is a high degree of flexibility for the design of the sides. Retaining blocks, a planted border or other edging features can be used based on your overall landscape's aesthetic.

Water can be directed to the rain garden through a pipe or along a rock-lined trench. If a pipe is used, ensure that there is a way to clean out leaves or other debris to prevent clogging.



Credit: Oregon State University

Step 4: Plant some native plants

Plants chosen for a rain garden are a personal choice and can match existing landscaped areas. Choose plants based on the site's light, moisture and soil characteristics. Hawai'i is home to a wide variety of native plants found nowhere else on Earth. Native plants are adapted to local conditions and can handle the periodic wet and dry conditions found in rain gardens. There are also a number of culturally significant "canoe plants" that were brought to Hawai'i by Polynesian explorers that are suitable for rain gardens. The possibilities for rain garden design and plant selection are endless.

Step 5: Add a sump (beach shower runoff only)

Capturing runoff from beach-rinse showers in a rain garden can be a great way to augment irrigation of the garden and filter additional gray water. However, a sump or other system must be included to allow for the regular removal of sand that accumulates as it is washed off of beachgoer's bodies, so that sand does not clog the system. Combined beach-shower rain gardens are best suited for places that have sufficient maintenance capacity to empty accumulated sand regularly (i.e. on a weekly basis).

Important Reminders

1. Ensure you have all the necessary permits (i.e. Special Management Area Permit, Grading and Grubbing Permit etc.).
2. Be sure to avoid all underground utilities. Before you dig, locate buried utilities by calling 811, the direct line to the Hawai'i Utility Notification Center (open 24/7).
3. Involve local stakeholders in the design and construction of the rain garden, and make certain all potential uses for the area are accommodated.

Thank You!

You can make a real difference in protecting Hawai'i's unique marine resources by constructing your own rain garden.

Additional Resources

Hawai'i Residential Rain Garden Manual
www.huihawaii.org/raingarden.html
This is a detailed rain garden manual covering aspects from siting and design to soil amendments and native Hawaiian plant lists.

Rain gauge atlas for Hawai'i
rainfall.geography.hawaii.edu/interactivemap.html
This atlas is useful to determine the average rainfall for a particular area.

List of Hawai'i's "canoe plants"
www.canoeplants.com/contents.html
This covers Hawai'i's canoe plants, their traditional uses and growing requirements.

List of common Hawaiian native plants
www.huihawaii.org/uploads/1/6/6/3/16632890/plant_foster_parent_handbook_final_draft_for_pdf.pdf
This provides details on how to propagate and care for Hawaiian native plants.

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The Coral Reef Alliance (CORAL) is an international nonprofit that unites communities to save coral reefs. In Hawai'i, CORAL is working with local partners to improve water quality for reefs and people through its Clean Water for Reefs Initiative.

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